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DESCRIPTION AND BIOLOGY OF *ACROLOPHUS PHOLETER*, (LEPIDOPTERA: TINEIDAE), A NEW MOTH COMMENSAL FROM GOPHER TORTOISE BURROWS IN FLORIDA

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Abstract.—Vacuum sampling of gopher tortoise burrows in Putnam County, Florida, has resulted in the discovery of a new species of tineid moth, *Acrolophus pholeter* Davis. The larva feeds on both the fecal pellets of the gopher tortoise and upon decaying plant debris within the burrow. Supplemented by numerous illustrations, the larval, pupal, and adult stages are described, and the general biology is summarized.

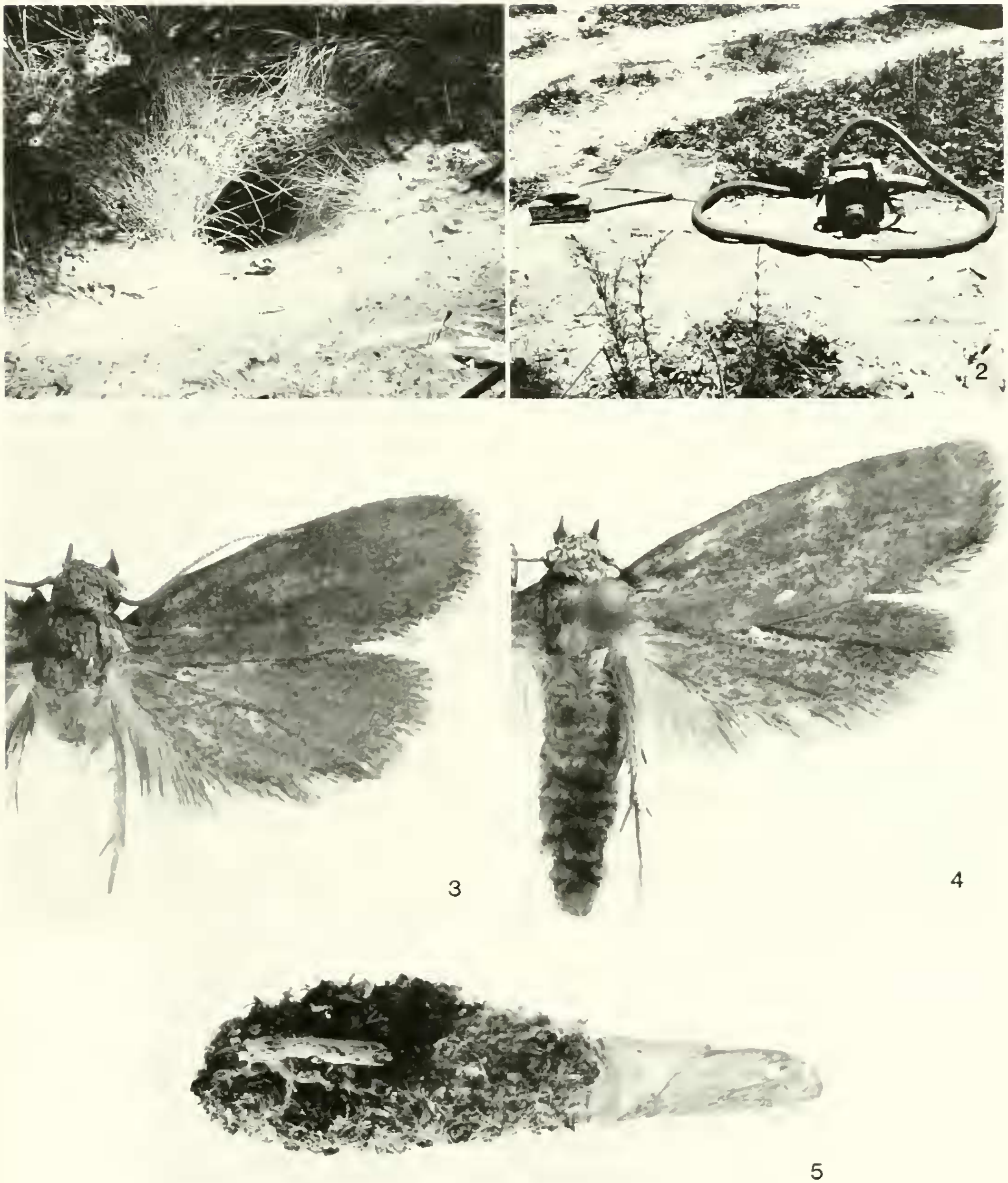
Key Words: Lepidoptera, Tineidae, moth biology, *Gopherus polyphemus*, gopher tortoise

Recent vacuum sampling for invertebrate commensals in the burrows of the gopher tortoise, *Gopherus polyphemus* Daudin, by the junior author has revealed the presence of a few arthropods previously unreported. Among these was a new species of *Acrolophus* that was found in abundance feeding on both tortoise fecal pellets and decaying plant debris within the burrow.

This is the first record of an *Acrolophus* commensal in an animal burrow. The subterranean, tube-constructing habit of the genus, however, is well known. Other Tineidae (all Acrolophinae) have been reported from rodent burrows (Hubbard 1901, Hubbell and Goff 1939, Davis et al. 1986), and at least one other moth, *Idia gopheri* (Smith), is known to inhabit the burrows of the gopher tortoise (Hubbard 1894, 1896, Smith 1899, Woodruff 1982). Hubbell and Goff (1939) reported that some arthropod commensals were true obligates and had not been collected outside gopher tortoise burrows. It is not known to what extent *Acrolophus pholeter* n. sp. is restricted to burrows of this tortoise or if the moth also frequents rodent burrows. The absence of previous *Acrolophus* collecting records suggests that its habitat may be rather restricted.

Since at least the Pleistocene, gopher tortoise burrows have provided a relatively stable habitat for the establishment of a diverse community of organisms. The integrity of individual burrows is normally maintained for five years or more. In terms of numbers of both vertebrate and invertebrate species found using gopher tortoise burrows, the diversity is one of the greatest yet studied in North American animal burrows (Milstrey 1986).

Sampling of organisms from gopher tortoise burrows can be a formidable task. Depending upon soil type and water table, burrows may extend up to 40 feet long and 12 feet deep (Young and Goff 1939). Excavation of such galleries can create a sizeable trench (Hubbard 1894). In recent years the use of vacuum suction devices (Butler et al. 1984) has greatly facilitated collecting from burrows without decimating the landscape



Figs. 1–5. *Acrolophus pholeter*, habitat, adults, and cocoon. 1, Entrance to gopher tortoise burrow, *Gopherus polyphemus*, Putnam Co., Florida. 2, Modified Echo R200 blower used for sampling invertebrate fauna from burrows. 3, Adult male, length of forewing 6.7 mm. 4, Adult female, length of forewing 8.2 mm. 5, Cocoon with pupal exuvium protruding, length of cocoon 13 mm.

(Fig. 2). One disadvantage of this technique is that it does not allow direct observations of the organisms' biology.

All material used in this study was collected by the junior author using a modified Echo R200 (R) blower (Kioritz Corp., Tokyo, Japan). Most adults (all type material) were reared from larvae collected by vacuuming.

Deposition of specimens referred to in this paper are: BMNH for British Museum of Natural History, London, England; FSCA, Florida State Collection of Arthropods, Gainesville, Florida; and USNM, National Museum of Natural History (formerly United States National Museum), Smithsonian Institution, Washington, D.C.

Acrolophus pholeter Davis, New Species
Figs. 3–62

Adult (Figs. 3–4).—Length of forewing: male, 5.5–6.7 mm; female, 7–9.5 mm. A moderately small moth with uniformly brownish gray wings, smooth head, and short labial palpi.

Head: Vestiture smooth over vertex and frons; scales uniformly brownish gray, relatively slender with rounded apices, appearing to arise from lower frons and curving upwards over vertex until they reach flattened, transversely oriented scale patches across occiput. Eye small, interocular index approximately 0.65, cornea relatively smooth with only scattered microsetae (Figs. 10–11); eyelash absent. Antenna about 0.4–0.6 the length of forewing, relatively longer in male, 46–49 segmented; scape uniformly brownish fuscous, smooth, without pecten; flagellomeres of similar color, fully scaled, simple in form with a few sensilla coeloconica along anterior margin (Figs. 12–13). Pilifer reduced, minutely setose (Fig. 7). Mandible absent. Maxillary palpus greatly reduced, 2 segmented; approximately 8–10 elongate sensilla arising from apical pit. Haustellum absent. Labial palpus short; length approximately 2.5× eye diameter, uniformly brownish gray, relatively smooth vestiture with slightly rough scales along venter of second segment.

Thorax: Pronotum and both fore and hindwings uniformly brownish gray. Venter somewhat paler, more light brown. Legs with smooth vestiture, light brownish gray dorsally, lighter buff ventrally; epiphysis greatly reduced (Fig. 14), length only about twice its width. Pretarsus of all legs unspecialized, with symmetrical claws, pulvilli, well developed arolium, and unguitractor plate bearing 5–6 transverse rows of scutes.

Abdomen: Uniformly light brownish gray.

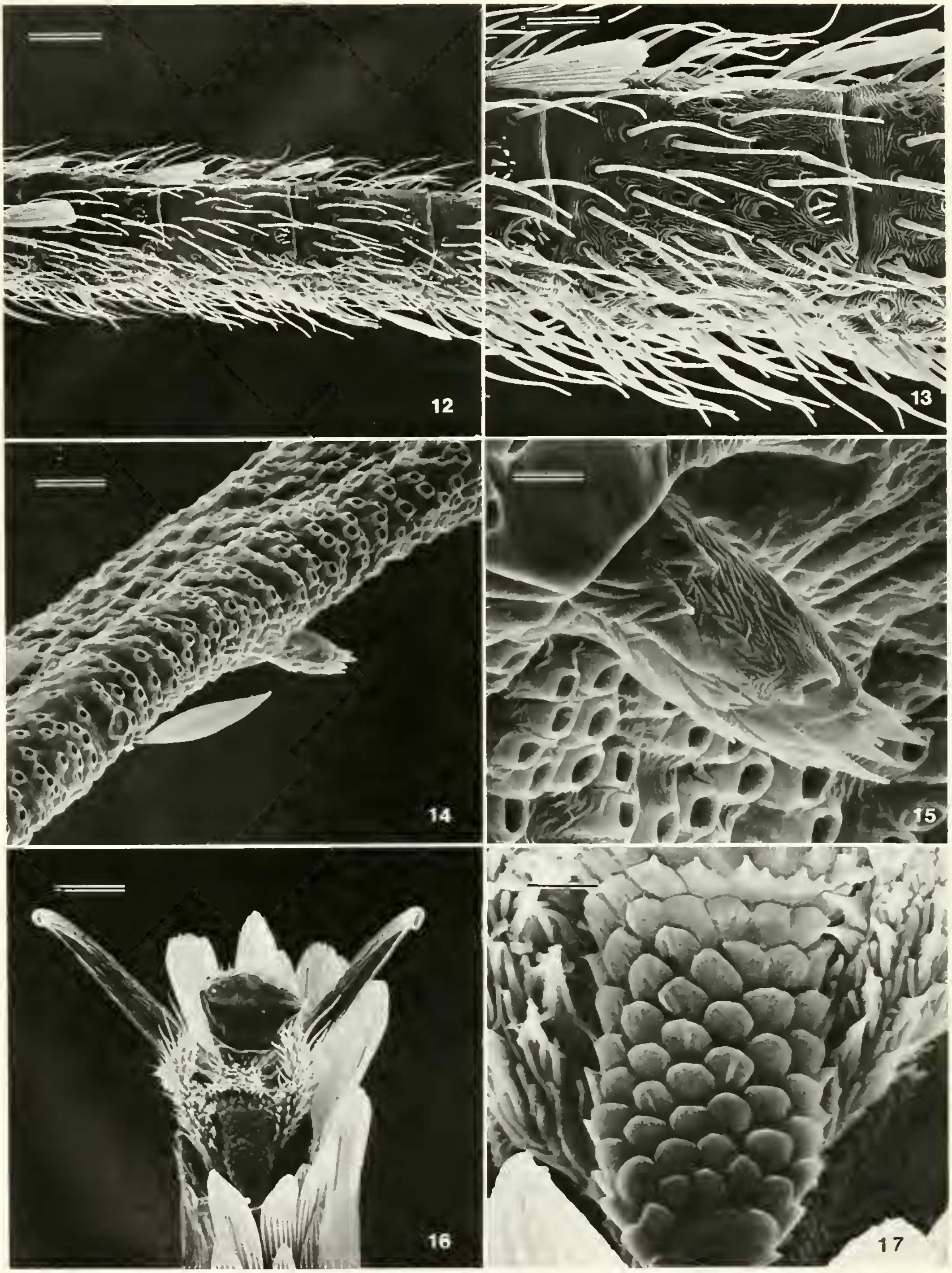
Male genitalia: As shown in Figs. 18–21. Uncus elongate, slender, and acute. Tegumen relatively broad and elongate. Vinculum slender; anterior margin slightly concave at middle. Gnathos a well developed median lobe with a relatively broad, truncate apex. Valva rather broad over basal half to sharply defined saccular lobe, abruptly narrowing beyond lobe to simple apex. Aedoeagus relatively short, approximately two-thirds the length of valva, and without cornuti; apex with a serrated cleft extending over one-fourth down right side.

Female genitalia: As shown in Fig. 22. Only a single pair of short, posterior apophyses present. Caudal margin of lamella antevaginalis smoothly curved. Ductus bursae very short, slightly thickened and constricted just before corpus bursae; latter simple, relatively small, membranous sac without spicules.

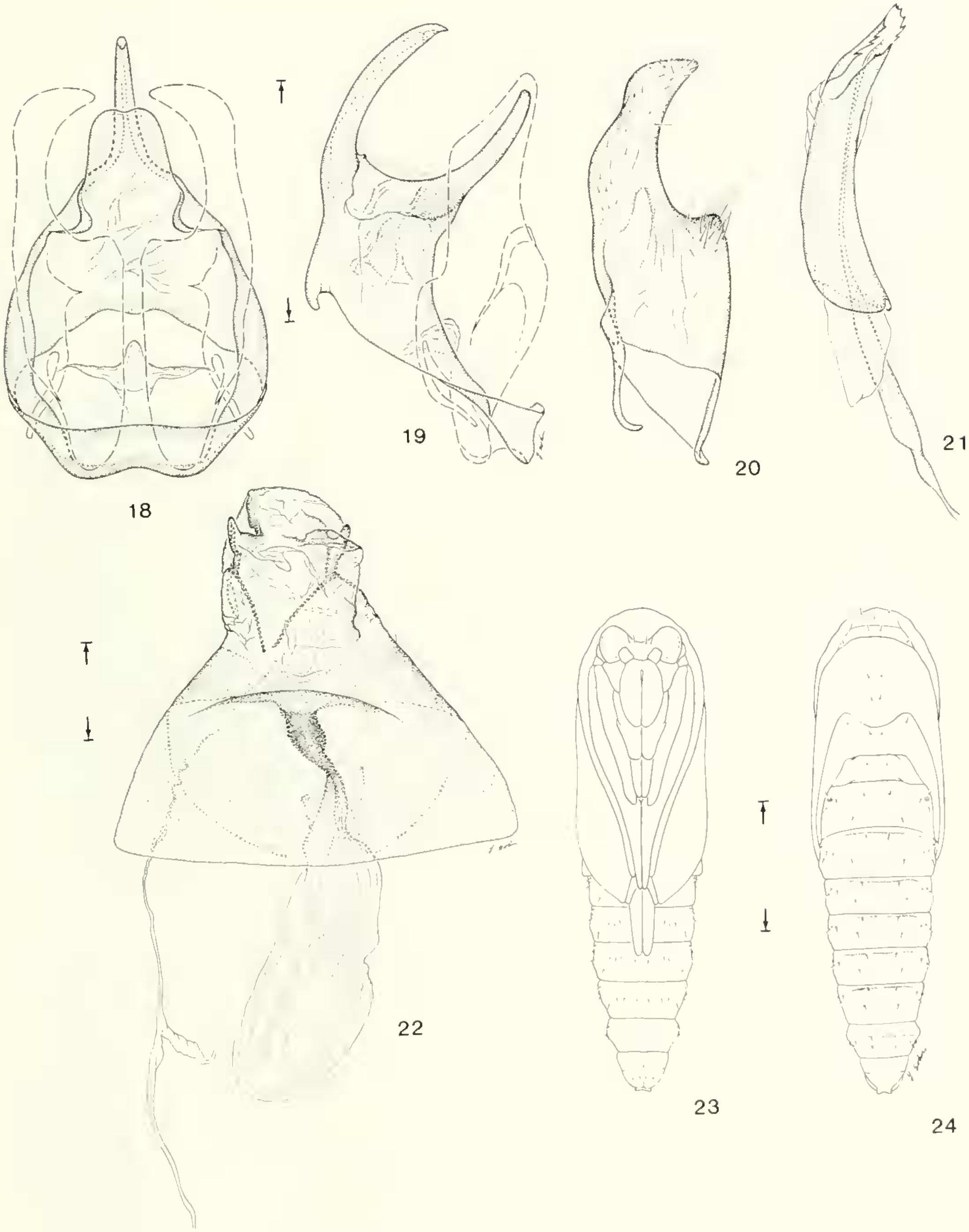
Larva (Figs. 33–62).—Length of largest larva 18 mm; diameter 2.1 mm. Body translucent, light yellowish brown with light brown thoracic and anal plates.

Head: Uniformly light reddish brown, darker around base of mandibles. Greatest width 1.4 mm, length 0.9 mm. AF2 arising well above (caudad) apex of frons. P2 more distant from P1 than P1 is to ecdysial line. Stemmata vestigial, probably non-functional; only three transparent vestiges remaining (Fig. 53); one situated above S2, a very small one well below S2, and an elongate hyaline

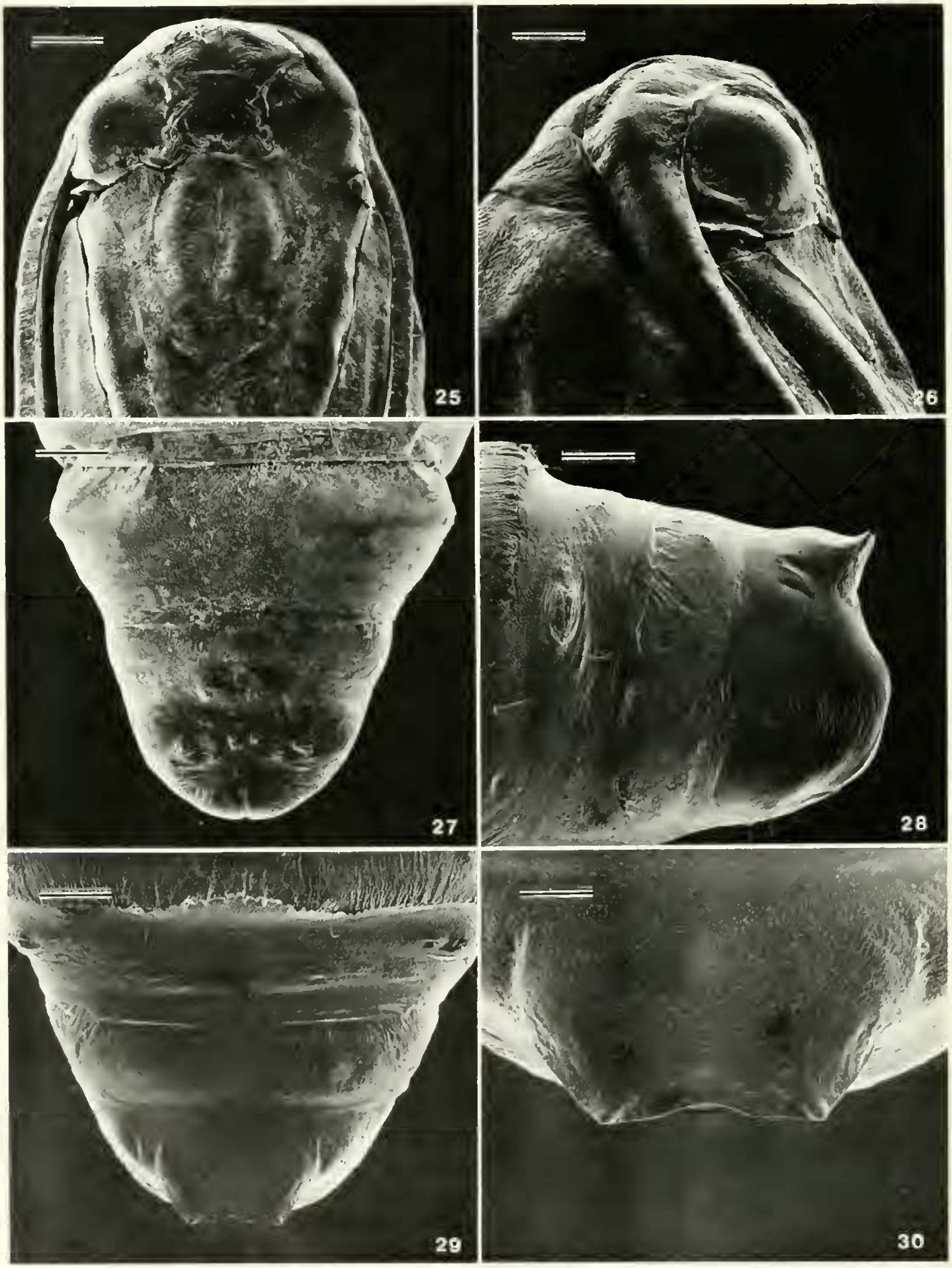
Figs. 6–11. Adult structure, *Acrolophus pholeter*. 6, Partial view of frons and mouthparts (88 μm). 7, Maxillary palpi and pilifers (37.5 μm). 8, Sensilla at apex of maxillary palpus (2.5 μm). 9, Sensilla at apex of labial palpus (8.8 μm). 10, Eye (88 μm). 11, Detail of cornea showing scattered interfacetal microsetae (19 μm). (Scale lengths in parentheses.)



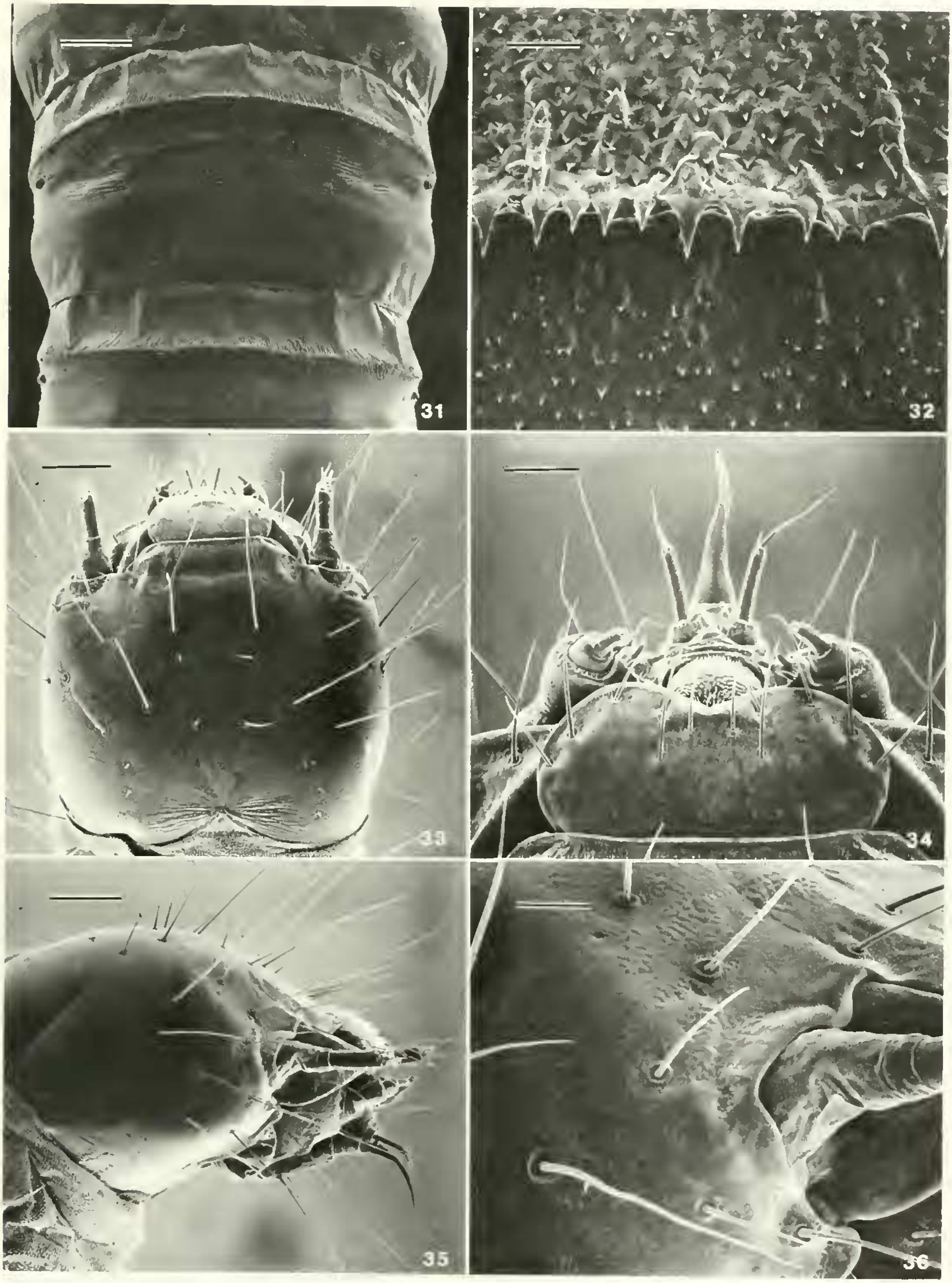
Figs. 12–17. Adult structure, *Acrolophus pholeter.* 12, Antenna near middle of flagellum (37.5 μm). 13, Detail of Fig. 12 showing sensilla coeloconica (16.5 μm). 14, Reduced epiphysis on foretibia (25 μm). 15, Detail of epiphysis (7.5 μm). 16, Pretarsus of hindleg (19 μm). 17, Detail of unguitractor plate (3.75 μm). (Scale lengths in parentheses.)



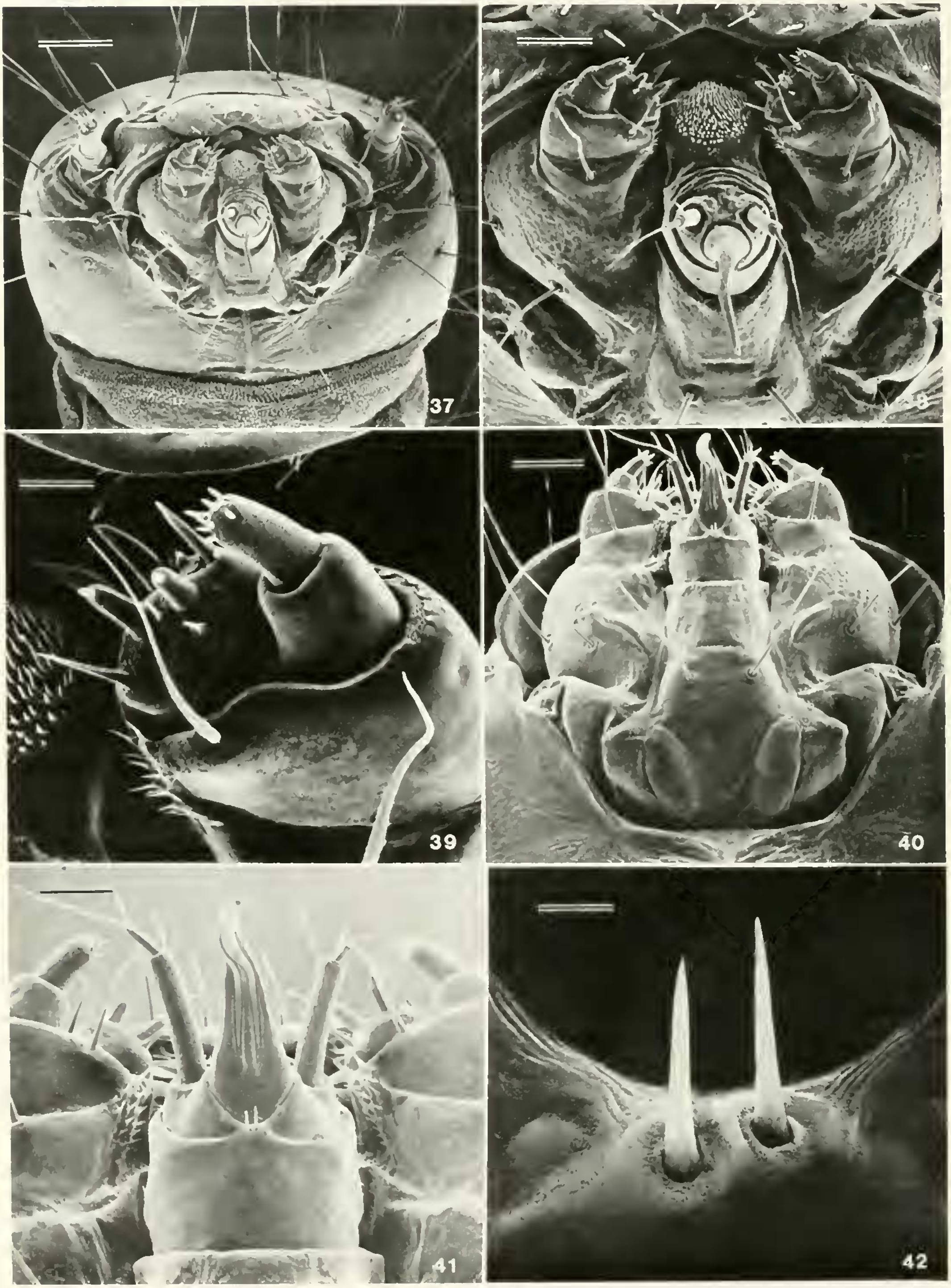
Figs. 18–24. *Acrolophus pholeter*. 18, Male genitalia, ventral view (0.5 mm). 19, Lateral view. 20, Lateral view of valva. 21, Lateral view of aedoeagus. 22, Female genitalia, ventral view (0.5 mm). 23, Pupa, ventral view (2 mm). 24, Dorsal view. (Scale lengths in parentheses.)



Figs. 25–30. *Acrolophus pholeter*, pupa. 25, Head, ventral view (0.3 mm). 26, Lateral view (0.22 mm). 27, Caudal end (A7–10) of abdomen (0.22 mm). 28, Lateral view, dorsum up (0.19 mm). 29, Dorsal view (0.22 mm). 30, Detail of dorsal cremaster, A10 (88 μm). (Scale lengths in parentheses.)

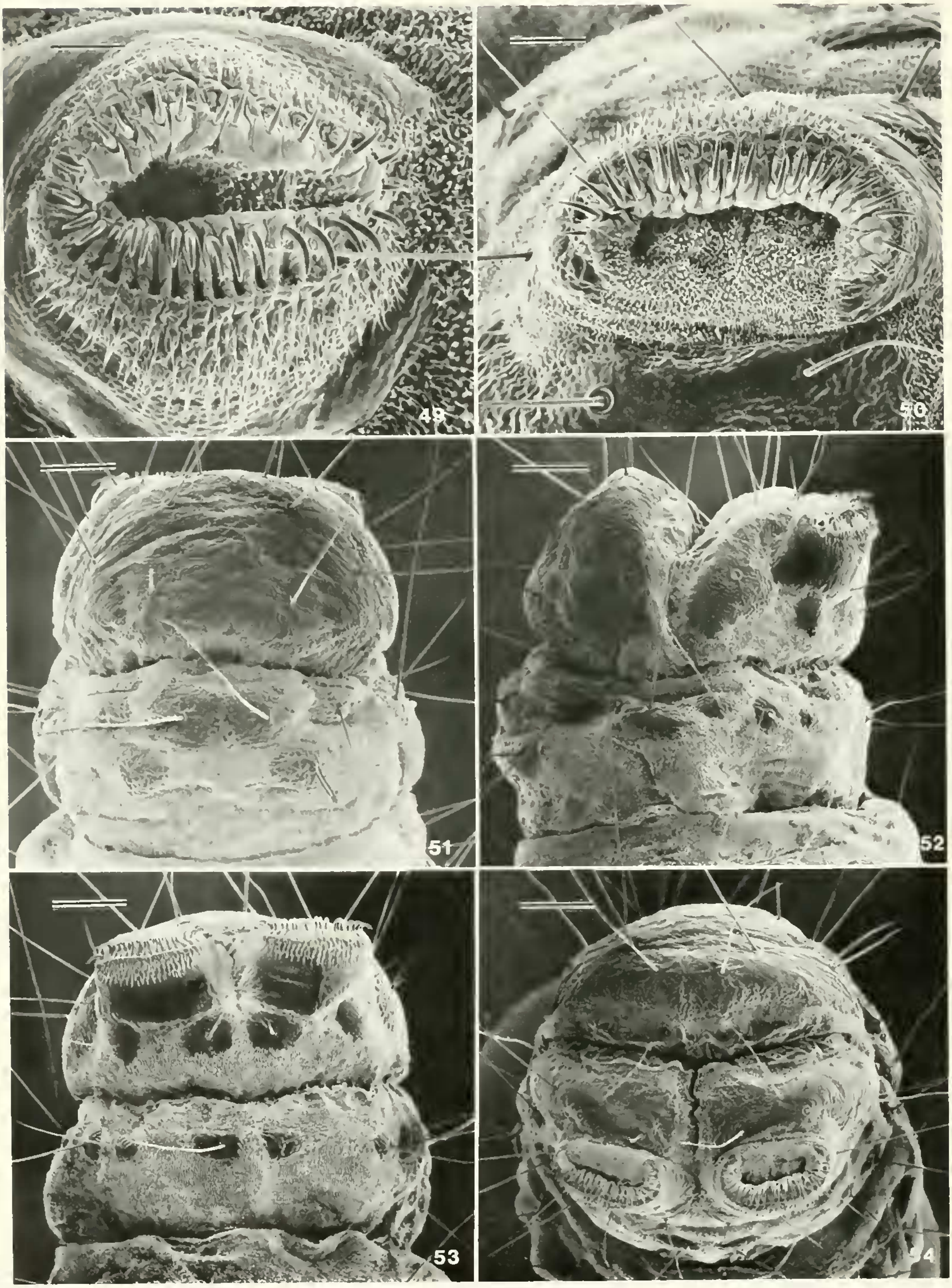


Figs. 31–36. *Acrolophus pholeter.* 31, Pupa, dorsum of A4–5 (0.43 mm). 32, Detail of spine row, A5 (30 μm). 33, Larva, dorsal view of head (0.19 mm). 34, Dorsal view of labrum and mouthparts (68 μm). 35, Lateral view of head (0.17 mm). 36, Lateral view of stemmatal area (60 μm). (Scale lengths in parentheses.)

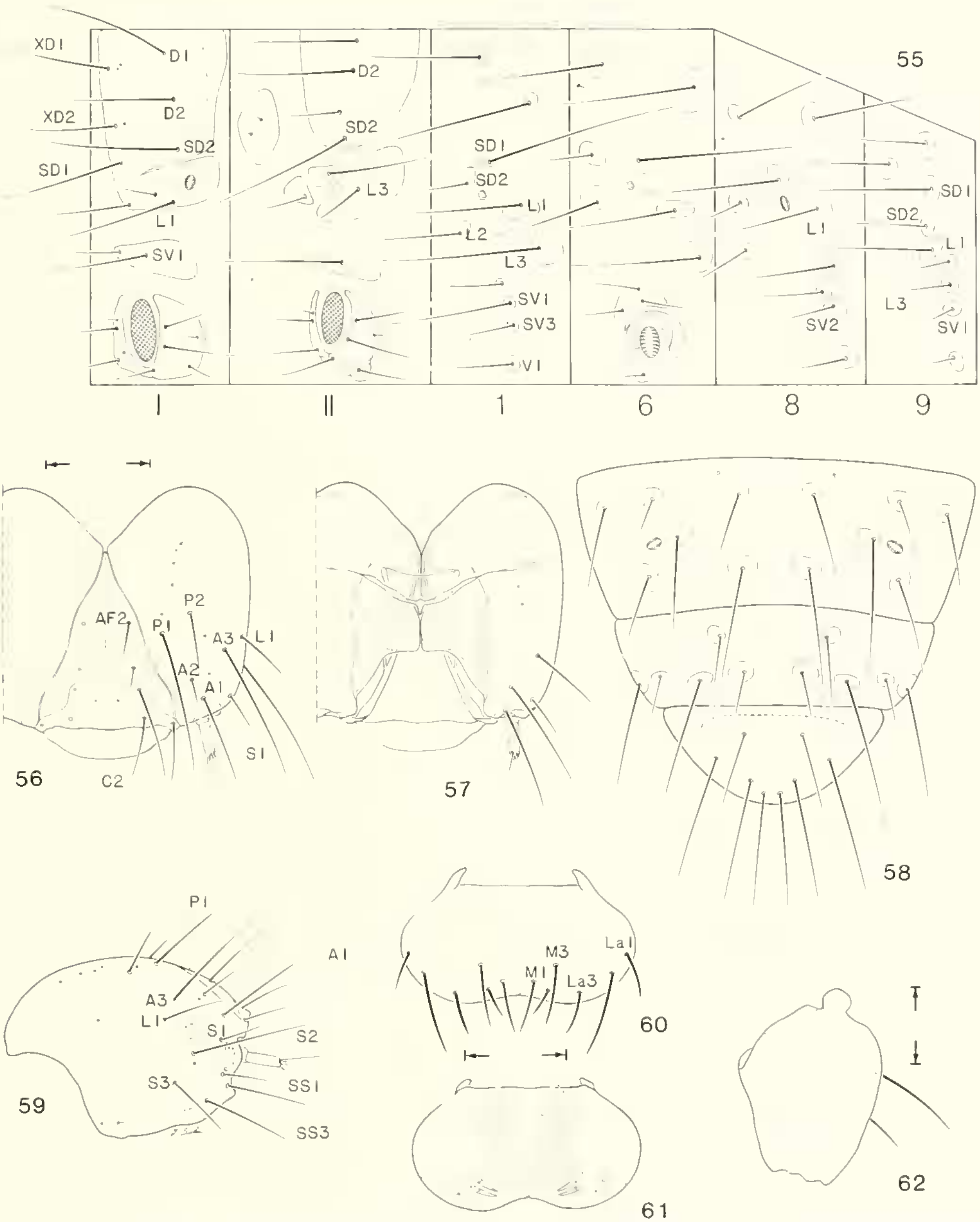


Figs. 37–42. *Acrolophus pholeter*, larva. 37, Head, frontal view (0.15 mm). 38, Maxillae and labium (68 μm). 39, Detail of maxilla (22 μm). 40, Ventral view of maxillae and labium (88 μm). 41, Detail of spinneret and labial palpi (37.5 μm). 42, Detail of secondary labial setae in Fig. 41 (3.75 μm). (Scale lengths in parentheses.)

Figs. 43–48. *Acrolophus pholeter*, larva. 43, Antenna (43 μm). 44, Detail of antennal apex (12 μm). 45, Lateral view of prothorax (0.22 mm). 46, Ventral view of prothorax (0.22 mm). 47, Tarsal claw (11.5 μm). 48, Prolegs, A5 (0.15 mm). (Scale lengths in parentheses.)



Figs. 49–54. *Acrolophus pholeter*, larva. 49, Crochets on proleg 5 (38.5 μm). 50, Anal proleg, A10 (60 μm). 51, Segments A9–10, dorsal view (0.19 mm). 52, Lateral view (0.19 mm). 53, Ventral view (0.19 mm). 54, Caudal view (0.19 mm). (Scale lengths in parentheses.)



Figs. 55–62. *Acrolophus pholeter*, larva. 55, Chaetotaxy of body, segments T1–2, A1, 6, 8–9. 56, Head, dorsal view (0.5 mm). 57, Ventral view. 58, Segments A8–10, dorsal view. 59, Head, lateral view. 60, Labrum, dorsal view (0.2 mm). 61, Ventral view. 62, Mandible (0.2 mm). (Scale lengths in parentheses.)

area anterior to S2; the latter apparently the remnant of three fused stemmata. Apical segment of antenna relatively long; sensilla as in Figs. 43–44. Labrum with M1 and 2 near anterior margin; M3 more remote. Mandible somewhat tapered, with 4 small cusps. Maxilla as in Figs. 38–39. Spinneret elongate, slender; labial palpus 2-segmented, basal segment elongate with a short apical seta; apical segment greatly reduced, about 0.25 the length of basal segment, with an elongate seta nearly equal in length to both segments; apex of mentum with a pair of minute secondary labial setae (Figs. 41–42).

Thorax: Pronotal and mesonotal plates light brown. Spiracular plate almost completely separated from pronotal plate; all 3 lateral setae together on spiracular plate. Coxal plates separated slightly. Tarsal claw as in Fig. 47.

Abdomen: A1–6 with 11 pairs of primary setae, SV trisetose. Ventral crochets in a uniserial ellipse of approximately 30 hooks; sides of proleg densely covered with small, scattered spines, anal proleg with approximately 21 hooks in a half ellipse open to the rear. A8 with spiracle greatly enlarged, equalling size of prothoracic spiracle; 10 pairs of primary setae, SV bisetose. A9 with 9 setal pairs, SV unisetose. Anal plate light brown, bearing 4 pairs of setae.

Pupa (Figs. 23–32).—Length of largest pupa: male, 7.2 mm; female, 11 mm. Light reddish brown in color. Vertex smooth except for a pair of minute setae. Antenna and labial palpus of relatively equal length in both sexes; antenna extending to caudal margin of A3 and just short of wings which extend to caudal margin of A4; labial palpus short. Mesonotum with two pairs of minute setae clustered together near midline. Dorsum of A3–8 with a transverse ridge like row of minute spines near anterior margin. A9 + 10 relatively smooth except for a cluster of 3 pairs of minute spines ventrally and a large, slightly bilobed ridge dorsally (Figs. 28–30).

Holotype.—Male, (with associated pupal exuvium and cocoon) Roberts' Ranch, ca. 6 km north of Hollister, Putnam Co., Florida; em. 12 May 1985, E. G. Milstrey, (USNM).

Paratypes.—FLORIDA: Same data as holotype except: 2 ♂, 3 ♀, em. Sept. 1984; 5 ♂, 4 ♀, em. Nov. 1984; 3 ♀, em. 8 Dec. 1984; 3 ♂, 1 ♀, em. 19 Dec, 1984; 1 ♂, m. 5 Feb. 1985; 3 ♀, em. 5 May 1985; 1 ♀, 9 May 1985; em. 11 May 1985; 2 ♂, 3 ♀, em. 12 May 1985; 4 ♂, 1 ♀, em. 17 May 1985; 1 ♀, 12 June 1985, em. 30 June 1985; 1 ♀, em. 20 July 1985; 1 ♀, 10 July 1985, em. 23 July 1985; 60 larvae, 26 July 1985; 68 larvae, 9 Sept. 1985. Paratypes deposited in BMNH, FSCA, and USNM.

Host.—Larval substrate consists of both decaying plant debris within burrow of gopher tortoise and fecal pellets of tortoise.

Flight period.—Difficult to assess; adults were collected from burrows through much of the year.

Distribution.—Known only from underground burrows of the gopher tortoise in the sandhill habitat of Putnam County, northeastern Florida.

Etymology.—The specific name is derived from the Greek *pholeter* (one who lurks in a hole), in reference to its subterranean behavior.

Discussion.—*Acrolophus pholeter* does not appear closely allied to any North American *Acrolophus*. In addition to its distinctive male genitalia, this species is unusual in possessing a smooth head and greatly reduced epiphysis. In color pattern, it superficially resembles a nearly unicolorus, undescribed species from southern Florida and Texas.

Even less can be summarized about larval relationships because of the great inadequacy of our knowledge. Compared with the few *Acrolophus* larvae ever studied (e.g. Davis 1987), the chaetotaxy of *A. pholeter* appears little differentiated. However, the atypical stemmatal reduction in this species, particularly the apparent fusion of the three anterior stemmata, is probably characteristic for the species.

Biological observations.—Biology of this species has been determined from laboratory and field observations. Apparently, the species is restricted to burrows of the gopher tortoise, *Gopherus polyphemus,* in sandhill habitats (Fig. 1). Tortoise burrows sampled outside the sandhill biome were found not to contain *A. pholeter*. The sandhills are relict dunes from the Pleistocene and earlier epochs (Cooke 1945, Laessle 1958). The vegetation of this habitat is characterized by longleaf pines, *Pinus palustris*, several oaks, *Quercus laevis* and *margaretta*, with an understory of wiregrass, *Aristida stricta*, and various herbs. The study site was in Putnam County, 6 km north of Hollister (29°41′40″N–81°48′10″W).

Collections were made every six weeks by vacuum extraction of the burrow using a modified Echo leaf blower similar to that described by Butler et al. (1984). Larvae, pupae and adults were obtained but eggs were not detected. Larval densities ranged up to 30 per burrow. In repeatedly sampled burrows, population estimates, based upon removal sampling estimates (Carle and Maughan 1980), indicated larval numbers commonly were 3 to 16. A few burrows not sampled routinely gave higher estimates, up to as high as 200. First instar larvae were found from May to November. All other stages were present year round. In the later part of the summer and early fall the pupating larvae probably were of two generations; the previous year's and offspring of the spring emergence. Larval development was estimated to require anywhere from 7 to 16 months and most likely around 11 months (± one month) for most individuals. One lab reared larva, field collected in its last larval stage, took 15 months to pupate. The pupation period is relatively short, normally requiring one to two weeks for adult eclosion.

Pupae and adults were infrequently collected in the burrows from May to September. Pupal cocoons (Fig. 5) were constructed of loosely woven silk to which are attached sand grains and larval frass. Apparently, pupation was triggered by unknown narrow microclimatic conditions present in individual burrows, because when pupae were found there were commonly more than one, and in other adjacent burrows none were found. Adults collected from burrows had wings that were badly tattered with few scales remaining on the body and wings. The poor condition of the adults was not due to the sampling method but probably due to abrasion occurring during normal adult activity within the sandy burrows.

As larval size increased in the burrows, density decreased. Larvae were found to be cannibalistic in laboratory studies. Silk lined larval galleries were usually constructed just below the soil surface in the floor of the burrow. Larval galleries could exceed 30 cm in length and were often branched. Larvae traveled forward and backward in these galleries, always facing the same direction. Feeding occurred at the entrance and fecal pellets were deposited on the soil surface at the other end.

Larvae were successfully reared on gopher tortoise fecal pellets. The fecal pellets used were mostly partially disgested wiregrass and some oak leaves. Although fecal material was available in the burrows, its abundance was always low and competition for it was high. The amount of available fecal material was generally too low to support the *Acrolophus* population present. Also, larvae were very common in burrows that no longer had resident tortoises. In active burrows, tortoises frequently re-excavated their burrows, and in those burrows larval populations were significantly decreased if not exterminated. Larval density was positively correlated with burrows that accumulated leaves and other debris. Apparently this rapidly decomposing organic leaf litter was their primary food source. Laboratory studies on limited numbers of larvae found that they would survive on the litter but that growth rates were lower.

The unique humidity situation in the burrow appears to be responsible for restricting the species to this habitat. In the sandhill gopher tortoise burrows studied, relative humidities were in the mid to high 90's but the percent water in the soil was low (0–5%) year round. In the laboratory inside an environmental chamber, larvae were found to survive only within these limits. Mature larvae left their silk galleries and moved to drier conditions to pupate. Pupae in the laboratory could be reared at room temperature and normal humidity levels.

The larvae of the antlion, *Glenurus gratis* (Say), and larvae of an undescribed therivid fly, *Arenagena* sp. were found to prey upon the *Acrolophus* larvae. Lepidoptera larvae were the only prey either would take under laboratory conditions. *Glenurus gratis* was probably the major predator. Its larval population numbers were more strongly correlated with *Acrolophus* larval numbers. Both prefer the same burrows and both are restricted to the drier, looser sand near the entrances where the leaves collect; the therivid was more ubiquitous.

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Literature Cited

Butler, J. F., K. H. Holscher, O. Adeyeye, and E. P. J. Gibbs. 1984. Sampling techniques for burrow dwelling ticks in reference to potential African swine fever virus vectors, p. 1065–1074. *In* D. A. Griffiths and C. E. Bowman, eds., Acarology IV Volume 2. Ellis Horwood Ltd. Chichester, England.

Carle, F. L. and O. E. Maughan. 1980. Accurate and efficient estimation of benthic populations: A comparison between removal estimation and conventional sampling techniques. Hydrobiologia 71: 181–187.

Cooke, C. W. 1945. Geology of Florida. Florida Geological Survey Bulletin, 29: 1–339.

Davis, D. R., D. H. Clayton, D. H. Janzen, and A. P. Brooke. 1986. Neotropical Tineidae, II: Biological notes and descriptions of two new moths phoretic on spiny pocket mice in Costa Rica (Lepidoptera: Tineoidea). Proceedings of the Entomological Society of Washington 88(1): 98–109.

Davis, D. R. 1987. Tineidae, pp. 362–365. *In* F. W. Stehr, ed., Immature Insects. Kendall/Hunt Publishing Co., Dubuque, Iowa.

Hubbard, H. G. 1894. The insect guests of the Florida land tortoise. Insect Life 6(4): 302–315.

———. 1896. Additional notes on the insect guests of the Florida land tortoise. Proceedings of the Entomological Society of Washington 3(5): 299–302.

———. 1901. Letters from the southwest: Insect fauna in the burrows of desert rodents. Proceedings of the Entomological Society of Washington 4: 361–364.

Hubbell, T. H. and C. C. Goff. 1939. Florida pocket-gopher burrows and their arthropod inhabitants. Proceedings of the Florida Academy of Science, 4: 127–166.

Laessle, A. M. 1958. The origin and successional relationship of sand-hill vegetation and sand pine scrub. Ecological Monographs 28: 361–387.

Milstrey, E. G. 1986. Ticks and invertebrate commensals in gopher tortoise burrows: Implications and importance, Pp. 4–15. *In* D. R. Jackson and R. J. Bryant, eds., The Gopher Tortoise and its Community. Proceedings 5th Annual Meeting of the Gopher Tortoise Council. Florida State Museum, University of Florida, Gainesville, Florida.

Smith, J. B. 1899. Description of the gopher moth. Canadian Entomologist 31: 94–95.

Woodruff, R. E. 1982. Arthropods of gopher burrows, pp. 25–49. *In* R. Franz and R. J. Bryant, eds., The Gopher Tortoise and its Sandhill Habitat. Proceedings of the 3rd Annual Meeting of the Gopher Tortoise Council. Tall Timbers Research Station, Tallahassee, Florida.

Young, F. N. and C. C. Goff. 1939. An annotated list of the arthropods found in the burrows of the Florida gopher tortoise, *Gopherus polyphemus* (Daudin). The Florida Entomologist 22(4): 53–62.